UTILITY PATENT APPLICATION TRANSMITTAL

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METHOD AND SYSTEM FOR OPTICAL TRANSMISSION

ADOPTING DISPERSION COMPENSATION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method and system for optical transmission adopting dispersion compensation.

Description of the Related Art

Owing to recent developments of low-loss silica optical fibers, various optical fiber communication systems each using such an optical fiber as a transmission line have been put to practical use. The optical fiber itself has a very wide band. However, a transmission capacity by the optical fiber is actually limited by a system design. The most important limitation is due to waveform distortion by chromatic dispersion occurring in the optical fiber. Further, the optical fiber attenuates an optical signal at a rate of about 0.2 dB/km, for example. Loss of the optical signal due to this attenuation has been compensated for by adopting an optical amplifier such as an erbium doped fiber amplifier (EDFA) that is a typical example. The EDFA has a gain band in a 1.55 μm band where a silica optical fiber gives

1

a lowest loss.

The chromatic dispersion that is often referred to simply as dispersion is a phenomenon such that the group velocity of an optical signal in an optical fiber changes as a function of the wavelength (or frequency) of the optical signal. In a standard single-mode fiber, for example, an optical signal having a longer wavelength propagates faster than an optical signal having a shorter wavelength in a wavelength region shorter than 1.3 μm, and the resultant dispersion is usually referred to as normal dispersion. In this case, the dispersion (whose unit is ps/nm/km) takes on a negative value. In contrast, an optical signal having a shorter wavelength propagates faster than an optical signal having a longer wavelength in a wavelength region longer than 1.3 μm, and the resultant dispersion is usually referred to as anomalous dispersion. In this case, the dispersion takes on a positive value.

In recent years, the nonlinearities of an optical fiber have received attention in association with an increase in optical signal power due to the use of an EDFA. The most important nonlinearity that limits a transmission capacity is an optical Kerr effect occurring in an optical fiber. The optical Kerr effect is a

phenomenon such that the refractive index of an optical fiber changes with the power or intensity of an optical signal. A change in the refractive index modulates the phase of an optical signal propagating in an optical fiber, resulting in the occurrence of frequency (wavelength) shift near the leading edge and the trailing edge of an optical waveform. This phenomenon is known as self-phase modulation (SPM). There is a possibility that such a change in spectrum due to SPM may further enlarge the waveform distortion due to chromatic dispersion.

In this manner, the chromatic dispersion and the optical Kerr effect impart waveform distortion to an optical signal with an increase in transmission distance. Accordingly, to allow long-haul transmission by an optical fiber while ensuring a transmission quality, the chromatic dispersion and the nonlinearity must be controlled, compensated, or suppressed.

As a method for compensating for dispersion in an optical fiber transmission system, a method using a dispersion compensator is known. For example, the dispersion compensator is configured so as to include a dispersion compensating fiber (DCF) having such a dispersion as canceling the dispersion of an optical fiber transmission line.

3

Known as a form of the optical fiber transmission system is a linear repeater system configured by connecting a plurality of segments each formed from an optical fiber and providing an optical amplifier at each connection point of these segments. This kind of system usually includes a plurality of dispersion compensators, and each dispersion compensator is provided in association with an optical transmitter, each optical amplifier, or an optical receiver. Each dispersion compensator is designed so that the total dispersion over the optical fiber transmission line is made to fall within tolerance by the addition of a dispersion given by each dispersion compensator. Accordingly, if there are variations in length of the optical fiber forming each segment, each dispersion compensator cannot be easily designed.

In another respect, the optical fiber to be used as the optical fiber transmission line is of various kinds such as a single-mode fiber (SMF) having a zero-dispersion wavelength of about 1.3 μm and a dispersion shifted fiber (DSF) having a zero-dispersion wavelength of about 1.55 μm. The SMF has a low loss in a wavelength band of 1.55 μm, but has a relatively large dispersion (e.g., 18 ps/nm/km) in this wavelength band. The SMF is

4

widely installed at present, and can also support WDM
(wavelength division multiplexing) transmission. On the
other hand, the DSF is a fiber having a zero-dispersion
wavelength shifted into a 1.55-μm band that is a low-loss
wavelength band, and the amount of installation of the
DSF is yet small at present. Further, the DSF is
susceptible to nonlinearity in WDM transmission. To
reduce the susceptibility to nonlinearity, an NZ
(nonzero)-DSF having slight dispersion in the 1.55-μm
band has also been developed.

Also in such a case that a plurality of segments
formed from various kinds of optical fibers are mixed,
the placement of dispersion compensators and the
distribution of dispersion compensation amounts are
important in system design, and each dispersion
compensator cannot be easily designed.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention
to provide a method and system for optical transmission
in which dispersion compensators can be easily designed.

In accordance with a first aspect of the present
invention, there is provided a method for optical
transmission adopting dispersion compensation, comprising

the steps of (a) providing an optical fiber transmission line composed of a plurality of segments each having a length falling within a predetermined range; (b) providing an optical transmitter for supplying an optical signal to the optical fiber transmission line at one end of the optical fiber transmission line; (c) providing an optical receiver for receiving the optical signal from the optical fiber transmission line at the other end of the optical fiber transmission line; (d) providing an optical amplifier between any two adjacent ones of the segments; and (e) providing a dispersion compensator in association with each of the optical transmitter, the optical receiver, and the optical amplifier; the dispersion compensator providing a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range.

According to this method, each dispersion compensator can be configured so as to have a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range. For example, by preparing several kinds of dispersion compensators providing different dispersions and suitably applying to each segment the dispersion compensator selected according to the length of the segment, the

6

total dispersion over the optical fiber transmission line can be easily made to fall within tolerance, thereby easily designing each dispersion compensator. Thus, the object of the present invention can be achieved.

In accordance with a second aspect of the present invention, there is provided a method for optical transmission adopting dispersion compensation, comprising the steps of (a) providing an optical fiber transmission line including at least one first segment formed from a single-mode fiber and at least one second segment formed from a dispersion shifted fiber; (b) providing an optical transmitter for supplying an optical signal to the optical fiber transmission line at one end of the optical fiber transmission line; (c) providing an optical receiver for receiving the optical signal from the optical fiber transmission line at the other end of the optical fiber transmission line; (d) providing an optical amplifier between any two adjacent ones of the segments; and (e) providing a dispersion compensator in association with each of the optical transmitter, the optical receiver, and the optical amplifier except that corresponding to at least one end of the second segment.

In accordance with a third aspect of the present invention, there is provided a system for optical

7

transmission adopting dispersion compensation, comprising an optical fiber transmission line composed of a plurality of segments each having a length falling within a predetermined range; an optical transmitter for supplying an optical signal to the optical fiber transmission line from one end thereof; an optical receiver for receiving the optical signal from the other end of the optical fiber transmission line; an optical amplifier provided between any two adjacent ones of the segments; and a dispersion compensator provided in association with each of the optical transmitter, the optical receiver, and the optical amplifier; the dispersion compensator providing a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range.

In accordance with a fourth aspect of the present invention, there is provided a system for optical transmission adopting dispersion compensation, comprising an optical fiber transmission line including at least one first segment formed from a single-mode fiber and at least one second segment formed from a dispersion shifted fiber; an optical transmitter for supplying an optical signal to the optical fiber transmission line from one end thereof; an optical receiver for receiving the

8

optical signal from the other end of the optical fiber transmission line; an optical amplifier provided between any two adjacent ones of the segments; and a dispersion compensator provided in association with each of the optical transmitter, the optical receiver and the optical amplifier except that corresponding to at least one end of the second segment.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing some preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a preferred embodiment of the system for optical transmission according to the present invention;

FIGS. 2A, 2B, and 2C are block diagrams showing preferred embodiments of an optical transmitter, an optical amplifier, and an optical receiver in one-channel transmission, respectively;

FIGS. 3A, 3B, and 3C are block diagrams showing

preferred embodiments of the optical transmitter, the

optical amplifier, and the optical receiver in WDM

(wavelength division multiplexing) transmission;

FIG. 4 is a graph showing dispersion

characteristics of optical fibers applicable to the

present invention; and

FIG. 5 is a diagram showing an example of a

dispersion map obtained by the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Some preferred embodiments of the present invention

will now be described in detail with reference to the

attached drawings.

FIG. 1 is a block diagram showing a preferred

embodiment of the system for optical transmission

according to the present invention. This system has an

optical transmitter 2, an optical receiver 4, and an

optical fiber transmission line (optical fiber span) 6

connecting the optical transmitter 2 and the optical

receiver 4. The optical fiber transmission line 6 is

composed of a plurality of (e.g., four as shown) segments

8(#1) to 8(#4) each having a length falling within a

predetermined range. An optical amplifier for

compensating for the loss of an optical signal is

provided between any two adjacent ones of the segments

8(#1) to 8(#4). More specifically, an optical amplifier

10(#1) is provided between the segments 8(#1) and 8(#2);

an optical amplifier 10(#2) is provided between the

segments 8(#2) and 8(#3); and an optical amplifier 10(#3)

is provided between the segments 8(#3) and 8(#4).

In the case of one-channel transmission not

adopting WDM (wavelength division multiplexing), the

optical transmitter 2 launches an optical signal of one

channel into the optical fiber transmission line 6,

whereas in the case of adopting WDM, the optical

transmitter 2 launches WDM signal light obtained by

wavelength division multiplexing a plurality of optical

signals having different wavelengths into the optical

fiber transmission line 6. The optical receiver 4

receives the optical signal or the WDM signal light from

the optical fiber transmission line 6.

FIGS. 2A, 2B, and 2C are block diagrams showing

preferred embodiments of the optical transmitter 2, each

optical amplifier 10 (each of the optical amplifiers

10(#1), 10(#2), and 10(#3)), and the optical receiver 4

in one-channel transmission, respectively. As shown in

FIG. 2A, the optical transmitter 2 includes an E/O

(electro/optic) converter 12 for converting an electrical

signal corresponding to transmission data into an optical signal, and a postamplifier 14 for amplifying the optical signal. The optical signal amplified by the postamplifier 14 is launched from an output port 16 into the first segment 8(#1) of the optical fiber transmission line 6. A dispersion compensator DC is provided between the E/O converter 12 and the postamplifier 14.

As shown in FIG. 2B, the optical amplifier 10 includes a front-stage amplifier 22 and a rear-stage amplifier 24 cascaded between an input port 18 and an output port 20. A dispersion compensator DC is provided between the front-stage amplifier 22 and the rear-stage amplifier 24.

As shown in FIG. 2C, the optical receiver 4 includes a preamplifier 28 for amplifying an optical signal from an input port 26 connected to the fourth segment 8(#4) of the optical fiber transmission line 6, and an O/E (opto/electric) converter 30 for converting the amplified optical signal into an electrical signal. A dispersion compensator DC is provided between the preamplifier 28 and the O/E converter 30. Each dispersion compensator DC provides a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range of length of each of

12

the segments 8(#1) to 8(#4). Examples of this setting of the dispersion will be hereinafter described.

FIGS. 3A, 3B, and 3C are block diagrams showing preferred embodiments of the optical transmitter 2, each optical amplifier 10, and the optical receiver 4 in WDM transmission. As shown in FIG. 3A, the optical transmitter 2 includes a plurality of E/O converters 32 for outputting a plurality of optical signals having different wavelengths $\lambda 1$ to λn, an optical multiplexer (MUX) 34 for wavelength division multiplexing these optical signals to output resultant WDM signal light, and a front-stage amplifier 36 and a rear-stage amplifier 38 cascaded with each other to amplify the WDM signal light. The WDM signal light is launched from an output port 40 into the first segment 8(#1) of the optical fiber transmission line 6. A dispersion compensator DC is provided between the front-stage amplifier 36 and the rear-stage amplifier 38. Each E/O converter 32 functions to convert an electrical signal corresponding to transmission data into an optical signal. The plural E/O converters 32 are respectively connected to a plurality of input ports of the optical multiplexer 34. A single output port of the optical multiplexer 34 is connected to the front-stage amplifier 36.

13

As shown in FIG. 3B, the optical amplifier 10
includes a front-stage amplifier 46 and a rear-stage
amplifier 48 cascaded between an input port 42 and an
output port 44. A dispersion compensator DC is provided
between the front-stage amplifier 46 and the rear-stage
amplifier 48.

As shown in FIG. 3C, the optical receiver 4
includes a front-stage amplifier 52 and a rear-stage
amplifier 54 cascaded with each other to amplify WDM
signal light from an input port 50 connected to the
fourth segment 8(#4) of the optical fiber transmission
line 6, an optical demultiplexer (DMUX) 56 for separating
the amplified WDM signal light into a plurality of
optical signals having different wavelengths $\lambda 1$ to λn,
and a plurality of O/E converters 58 for respectively
converting these optical signals into electrical signals.
A dispersion compensator DC is provided between the
front-stage amplifier 52 and the rear-stage amplifier 54.
A single input port of the optical demultiplexer 56 is
connected to the rear-stage amplifier 54, and a plurality
of output ports of the optical demultiplexer 56 are
respectively connected to the plural O/E converters 58.
In each of the one-channel transmission and the WDM
transmission mentioned above, front-stage amplifiers and

14

rear-stage amplifiers are combined as required. In this case, by using a relatively low-noise amplifier as each front-stage amplifier and a relatively high-output amplifier as each rear-stage amplifier, a reduction in noise figure due to loss by each dispersion compensator can be prevented and a required high output can also be obtained. Further, in each of the optical transmitter and the optical receiver for WDM transmission, the combination of the front-stage amplifier and the rear-stage amplifier is intended to easily make flat the wavelength characteristic of gain.

FIG. 4 is a graph showing dispersion characteristics of optical fibers usable as each segment 8. In FIG. 4, the vertical axis represents dispersion (ps/nm/km) and the horizontal axis represents wavelength (μm). In the case that a general silica-based single-mode fiber (SMF) is used as each segment 8, the zero-dispersion wavelength of the SMF is about 1.3 μm. In this case, the dispersion falls in a region of anomalous dispersion for an optical signal having a wavelength longer than the zero-dispersion wavelength, and has a positive value. Conversely, the dispersion falls in a region of normal dispersion for an optical signal having a wavelength shorter than the zero-dispersion wavelength,

15

and has a negative value.

In the case of using an SMF as each segment 8, the wavelength of an optical signal is set to fall in a 1.55 μm band (e.g., 1.50 to 1.60 μm) giving a minimum loss in the SMF, so as to minimize the loss and maximize the length of each segment 8. Accordingly, the dispersion for the optical signal falls always in a region of anomalous dispersion. Accordingly, in the case that all the segments 8 are provided by SMFs, it is desirable to perform dispersion compensation in each segment 8. An example of setting on distribution or the like of dispersion compensation amounts in this case will be hereinafter described.

In the case that a dispersion shifted fiber (DSF) is used as each segment 8, the zero-dispersion wavelength of the DSF is about 1.55 μm. Also in this case, the dispersion falls in a region of anomalous dispersion for an optical signal having a wavelength longer than the zero-dispersion wavelength, and has a positive value. Conversely, the dispersion falls in a region of normal dispersion for an optical signal having a wavelength shorter than the zero-dispersion wavelength, and has a negative value.

Because the wavelength giving a minimum loss in the

16

DSF is also equal to about 1.55 μm, the wavelength of an
optical signal is set to fall in a 1.55 μm band.
Accordingly, whether the dispersion in the DSF falls in a
region of anomalous dispersion or in a region of normal
dispersion is determined according to the correlation
between the actual wavelength of an optical signal and
the zero-dispersion wavelength of the DSF. However, as
far as the wavelength of an optical signal is set in a
1.55-μm band, the dispersion (ps/nm) in the segment is
sufficiently small irrespective of whether the dispersion
in the DSF falls in an anomalous dispersion region or in
a normal dispersion region, so that no dispersion
compensation may be required in the segment formed from a
DSF. In other words, in the case that at least one
segment formed from a DSF and at least one segment formed
from an SMF are mixed, there is a possibility that the
application of a dispersion compensator to the segment
formed of a DSF may be omitted. An example of such a
configuration will also be hereinafter described.

Table 1

Segment Distance (km)	Dispersion Compensation Amount (ps/nm)		
	Optical Transmitter	Optical Amplifier	Optical Receiver
0-20	-600	-200	-200
20-40		-400	
40-60		-700	-600
60-80		-1000	

Table 1 shows an example of setting of the
dispersion compensation amount of each dispersion
compensator DC in the case that all the segments 8(#1) to
8(#4) shown in FIG. 1 are SMFs. In this example, the
dispersion (ps/nm; ditto for the following) of the
dispersion compensation DC in the optical transmitter 2
is set to -600. The dispersions of the dispersion
compensators DC in the optical amplifiers 10(#1) to
10(#3) and in the optical receiver 4 are set according to
the distance (km; ditto for the following) of the
corresponding segment 8 immediately upstream of each
optical component. For example, the dispersion of the
dispersion compensator DC in the optical amplifier 10(#1)
is set in such a manner that when the distance of the
segment 8(#1) is less than 20, the dispersion is set to
-200; when the distance of the segment 8(#1) is in the
range from 20 to less than 40, the dispersion is set to
-400; when the distance of the segment 8(#1) is in the

18

range from 40 to less than 60, the dispersion is set to -700; and when the distance of the segment 8(#1) is in the range from 60 to less than 80, the dispersion is set to -1000. Similarly, the dispersion of the dispersion compensator DC in the optical amplifier 10(#2) is set according to the distance of the segment 8(#2), and the dispersion of the dispersion compensator DC in the optical amplifier 10(#3) is set according to the distance of the segment 8(#3). Further, the dispersion of the dispersion compensator DC in the optical receiver 4 is set in such a manner that when the distance of the segment 8(#4) is less than 40, the dispersion is set to -200, and when the distance of the segment 8(#4) is in the range from 40 to less than 80, the dispersion is set to -600.

According to this preferred embodiment, the total dispersion over the optical fiber transmission line 6 can be easily made to fall within tolerance, so that the waveform distortion due to dispersion can be suppressed to thereby improve a transmission quality. Further, since the distance of each segment is set within a predetermined range (0-80 in this example), a transmission line loss can be easily compensated by each optical amplifier 10. Further, since it is not necessary

19

to increase the output power of each optical amplifier 10 to a given value or more, the waveform distortion due to nonlinearity can be suppressed to thereby improve a transmission quality. Further, since each dispersion compensator DC provides a dispersion selected from a plurality of stepwise varying dispersions determined according to a predetermined distance range (0-20, 20-40, 40-60, or 60-80), each dispersion compensator DC can be selected from a given menu. That is, several kinds of dispersion compensators having different dispersions may be prepared in advance and they may be selectively used according to the distance of each segment 8, thereby allowing easy construction of a system. Thus, it is possible to provide a method and system for optical transmission in which dispersion compensators can be easily designed.

There will now be described an example of setting of the dispersion compensation amount of each dispersion compensator DC in the case that a DSF is applied to at least one of the segments 8(#1) to 8(#4).

Table 2

DSF Applied Segment	Dispersion Compensation Amount (ps/nm)				
	Optical Transmitter	Optical Amplifiers			Optical Receiver
		#1	#2	#3	
First Segment	0	-600	-1000	-1000	-600
Second Segment	-600	-800	0		-800
Third Segment		-1000	-800	0	
Fourth Segment			-1000	-600	0

Table 2 shows an example of setting of the dispersion compensation amount of each dispersion compensator DC in the case that a DSF is applied to one of the segments 8(#1) to 8(#4) shown in FIG. 1 and SMFs are applied to the other segments. In the case that a DSF is applied to the first segment 8(#1), the dispersion compensator DC in the optical transmitter 2 is omitted, the dispersion of the dispersion compensator DC in the optical amplifier 10(#1) is set to -600, the dispersion of the dispersion compensator DC in the optical amplifier 10(#2) is set to -1000, the dispersion of the dispersion compensator DC in the optical amplifier 10(#3) is set to -1000, and the dispersion of the dispersion compensator DC in the optical receiver 4 is set to -600.

In the case that a DSF is applied to any one of the second segment 8(#2), the third segment 8(#3), and the

21

fourth segment 8(#4), the dispersion of the dispersion
compensator DC in the optical transmitter 2 is set to
-600. In the case that a DSF is applied to the second
segment 8(#2), the dispersion of the dispersion
compensator DC in the optical amplifier 10(#1) is set to
-800, the dispersion compensator DC in the optical
amplifier 10(#2) is omitted, the dispersion of the
dispersion compensator DC in the optical amplifier 10(#3)
is set to -1000, and the dispersion of the dispersion
compensator DC in the optical receiver 4 is set to -800.
In the case that a DSF is applied to the third segment
8(#3), the dispersion of the dispersion compensator DC in
the optical amplifier 10(#1) is set to -1000, the
dispersion of the dispersion compensator DC in the
optical amplifier 10(#2) is set to -800, the dispersion
compensator DC in the optical amplifier 10(#3) is omitted,
and the dispersion of the dispersion compensator DC in
the optical receiver 4 is set to -800. In the case that a
DSF is applied to the fourth segment 8(#4), the
dispersion of the dispersion compensator DC in the
optical amplifier 10(#1) is set to -1000, the dispersion
of the dispersion compensator DC in the optical amplifier
10(#2) is set to -1000, the dispersion of the dispersion
compensator DC in the optical amplifier 10(#3) is set to

22

-600, and the dispersion compensator DC in the optical receiver 4 is omitted.

The distance of each segment is set to 70, for example. Preferably, the distance of each segment is set within a predetermined range (0-80) as in the case that SMFs only are applied.

According to this preferred embodiment, a DSF is applied to any one of the segments 8(#1) to 8(#4), so that the dispersion compensator DC corresponding to one end of the segment to which the DSF is applied can be omitted. Accordingly, although a reduced number of dispersion compensators are used, the total dispersion over the optical fiber transmission line 6 can be easily made to fall within tolerance, so that the waveform distortion due to dispersion can be suppressed to thereby improve a transmission quality. Further, like the previous preferred embodiment, each dispersion compensator DC can be selected from a given menu, so that it is possible to provide a method and system for optical transmission in which dispersion compensators can be easily designed.

While a DSF is applied to only one segment in the above description related to Table 2, a plurality of DSFs may be applied to two or more segments.

23

Thus, by applying a DSF to at least one of the segments 8(#1) to 8(#4), the dispersion compensator DC corresponding to at least one end of each segment to which the DSF is applied can be omitted.

FIG. 5 is a diagram showing an example of a dispersion map obtained by the present invention. In FIG. 5, the vertical axis represents dispersion, and the horizontal axis represents position or distance on the optical fiber transmission line 6. Specifically, FIG. 5 shows a dispersion map in the case that a DSF is applied to the second segment 8(#2) in relation to Table 2. Although the dispersion compensator DC in the optical amplifier 10(#2) is omitted in this case as described above, it is understood from FIG. 5 that the total dispersion over the optical fiber transmission line 6 is made to fall within tolerance by the application of the present invention.

According to the present invention as described above, it is possible to provide a method and system for optical transmission in which dispersion compensators can be easily designed. The effects obtained by the specific preferred embodiments of the present invention have been described, so the description thereof will be omitted herein.

24

The present invention is not limited to the details of the above described preferred embodiments. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A method for optical transmission adopting dispersion compensation, comprising the steps of:

(a) providing an optical fiber transmission line composed of a plurality of segments each having a length falling within a predetermined range;

(b) providing an optical transmitter for supplying an optical signal to said optical fiber transmission line at one end of said optical fiber transmission line;

(c) providing an optical receiver for receiving said optical signal from said optical fiber transmission line at the other end of said optical fiber transmission line;

(d) providing an optical amplifier between any two adjacent ones of said segments; and

(e) providing a dispersion compensator in association with each of said optical transmitter, said optical receiver, and said optical amplifier;

said dispersion compensator providing a dispersion selected from a plurality of stepwise varying dispersions determined according to said predetermined range.

2. A method according to claim 1, wherein each of said segments is formed from a single-mode fiber having a zero-dispersion wavelength of about 1.3 μm.

3. A method according to claim 1, wherein said optical signal has a wavelength of about 1.55 μm.

4. A method according to claim 1, wherein said optical signal comprises a plurality of optical signals having different wavelengths obtained by wavelength division multiplexing.

5. A method for optical transmission adopting dispersion compensation, comprising the steps of:

(a) providing an optical fiber transmission line including at least one first segment formed from a single-mode fiber and at least one second segment formed from a dispersion shifted fiber;

(b) providing an optical transmitter for supplying an optical signal to said optical fiber transmission line at one end of said optical fiber transmission line;

(c) providing an optical receiver for receiving said optical signal from said optical fiber transmission line at the other end of said optical fiber transmission line;

(d) providing an optical amplifier between any two adjacent ones of said segments; and

(e) providing a dispersion compensator in association with each of said optical transmitter, said optical receiver, and said optical amplifier except that

27

corresponding to at least one end of said second segment.

6. A method according to claim 5, wherein said single-mode fiber has a zero-dispersion wavelength of about 1.3 μm, and said dispersion shifted fiber has a zero-dispersion wavelength of about 1.55 μm.

7. A method according to claim 5, wherein said optical signal has a wavelength of about 1.55 μm.

8. A method according to claim 5, wherein said optical signal comprises a plurality of optical signals having different wavelengths obtained by wavelength division multiplexing.

9. A system for optical transmission adopting dispersion compensation, comprising:

an optical fiber transmission line composed of a plurality of segments each having a length falling within a predetermined range;

an optical transmitter for supplying an optical signal to said optical fiber transmission line from one end thereof;

an optical receiver for receiving said optical signal from the other end of said optical fiber transmission line;

an optical amplifier provided between any two adjacent ones of said segments; and

28

a dispersion compensator provided in association with each of said optical transmitter, said optical receiver, and said optical amplifier;

said dispersion compensator providing a dispersion selected from a plurality of stepwise varying dispersions determined according to said predetermined range.

10. A system according to claim 9, wherein each of said segments is formed from a single-mode fiber having a zero-dispersion wavelength of about 1.3 μm.

11. A system according to claim 9, wherein said optical signal has a wavelength of about 1.55 μm.

12. A system according to claim 9, wherein:

said optical transmitter comprises an E/O converter for converting an electrical signal into said optical signal, and a postamplifier for amplifying said optical signal;

said dispersion compensator being provided between said E/O converter and said postamplifier.

13. A system according to claim 9, wherein:

said optical amplifier comprises a front-stage amplifier and a rear-stage amplifier cascaded with each other;

said dispersion compensator being provided between said front-stage amplifier and said rear-stage amplifier.

29

14. A system according to claim 9, wherein:

said optical receiver comprises a preamplifier for amplifying said optical signal, and an O/E converter for converting said optical signal into an electrical signal; said dispersion compensator being provided between said preamplifier and said O/E converter.

15. A system according to claim 9, wherein:

said optical transmitter comprises a plurality of E/O converters each for converting an electrical signal into said optical signal, a front-stage amplifier and a rear-stage amplifier cascaded with each other, and an optical multiplexer having a plurality of input ports respectively connected to said plurality of E/O converters and an output port connected to said front-stage amplifier;

said dispersion compensator being provided between said front-stage amplifier and said rear-stage amplifier.

16. A system according to claim 9, wherein:

said optical receiver comprises a front-stage amplifier and a rear-stage amplifier cascaded with each other, a plurality of O/E converters each for converting said optical signal into an electrical signal, and an optical demultiplexer having an input port connected to said rear-stage amplifier and a plurality of output ports

30

respectively connected to said plurality of O/E
converters;

said dispersion compensator being provided between
said front-stage amplifier and said rear-stage amplifier.

17. A system for optical transmission adopting
dispersion compensation, comprising:

an optical fiber transmission line including at
least one first segment formed from a single-mode fiber
and at least one second segment formed from a dispersion
shifted fiber;

an optical transmitter for supplying an optical
signal to said optical fiber transmission line from one
end thereof;

an optical receiver for receiving said optical
signal from the other end of said optical fiber
transmission line;

an optical amplifier provided between any two
adjacent ones of said segments; and

a dispersion compensator provided in association
with each of said optical transmitter, said optical
receiver and said optical amplifier except that
corresponding to at least one end of said second segment.

18. A system according to claim 17, wherein said
first segment has a zero-dispersion wavelength of about

31

1.3 μm, and said second segment has a zero-dispersion wavelength of about 1.55 μm.

19. A system according to claim 17, wherein said optical signal has a wavelength of about 1.55 μm.

20. A system according to claim 17, wherein:

said optical transmitter comprises an E/O converter for converting an electrical signal into said optical signal, and a postamplifier for amplifying said optical signal;

said dispersion compensator being provided between said E/O converter and said postamplifier.

21. A system according to claim 17, wherein:

said optical amplifier comprises a front-stage amplifier and a rear-stage amplifier cascaded with each other;

said dispersion compensator being provided between said front-stage amplifier and said rear-stage amplifier.

22. A system according to claim 17, wherein:

said optical receiver comprises a preamplifier for amplifying said optical signal, and an O/E converter for converting said optical signal into an electrical signal;

said dispersion compensator being provided between said preamplifier and said O/E converter.

23. A system according to claim 17, wherein:

said optical transmitter comprises a plurality of
E/O converters each for converting an electrical signal
into said optical signal, a front-stage amplifier and a
rear-stage amplifier cascaded with each other, and an
optical multiplexer having a plurality of input ports
respectively connected to said plurality of E/O
converters and an output port connected to said front-
stage amplifier;

said dispersion compensator being provided between
said front-stage amplifier and said rear-stage amplifier.

24. A system according to claim 17, wherein:

said optical receiver comprises a front-stage
amplifier and a rear-stage amplifier cascaded with each
other, a plurality of O/E converters each for converting
said optical signal into an electrical signal, and an
optical demultiplexer having an input port connected to
said rear-stage amplifier and a plurality of output ports
respectively connected to said plurality of O/E
converters;

said dispersion compensator being provided between
said front-stage amplifier and said rear-stage amplifier.

ABSTRACT OF THE DISCLOSURE

An optical fiber transmission line composed of a plurality of segments each having a length falling within a predetermined range is provided. An optical transmitter for supplying an optical signal to the transmission line is provided at one end of the transmission line. An optical receiver for receiving the optical signal from the transmission line is provided at the other end of the transmission line. An optical amplifier is provided between any two adjacent ones of the segments. A dispersion compensator is provided in association with each of the optical transmitter, the optical receiver, and the optical amplifier. The dispersion compensator provides a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range. According to this method, each dispersion compensator can be configured so as to have a dispersion selected from a plurality of stepwise varying dispersions determined according to the predetermined range. For example, by preparing several kinds of dispersion compensators providing different dispersions and suitably applying to each segment the dispersion compensator selected according to the length of the segment, the total dispersion over the optical fiber

34

transmission line can be easily made to fall within

tolerance, thereby easily designing each dispersion

compensator.
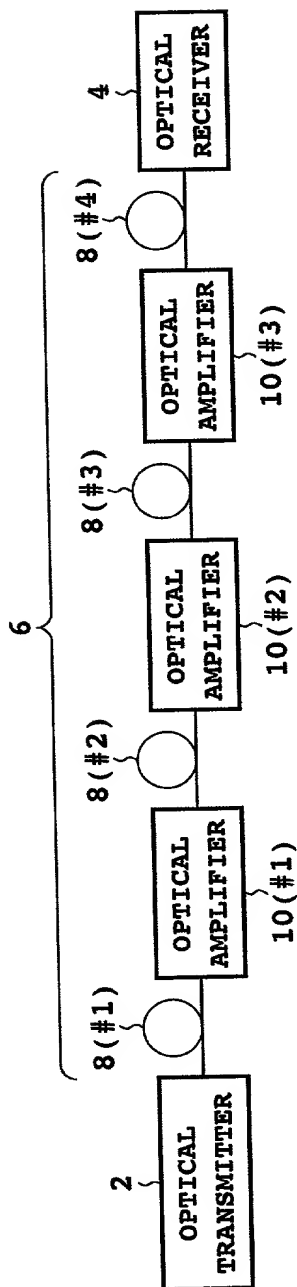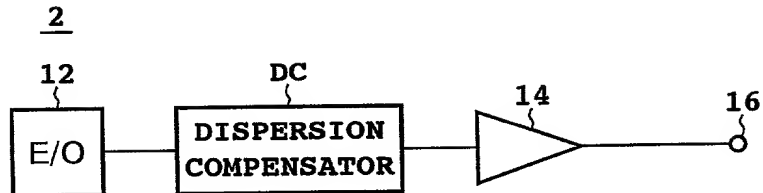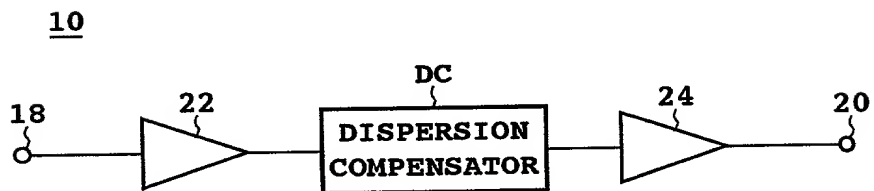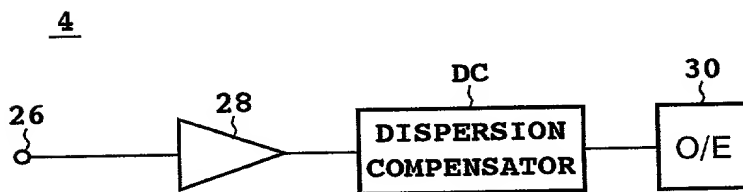
F I G. 1

FIG. 2A

<u>2</u>

12

DC

14

16

E/O → DISPERSION COMPENSATOR → ▷ → ○

FIG. 2B

<u>10</u>

18

22

DC

24

20

○ → ▷ → DISPERSION COMPENSATOR → ▷ → ○
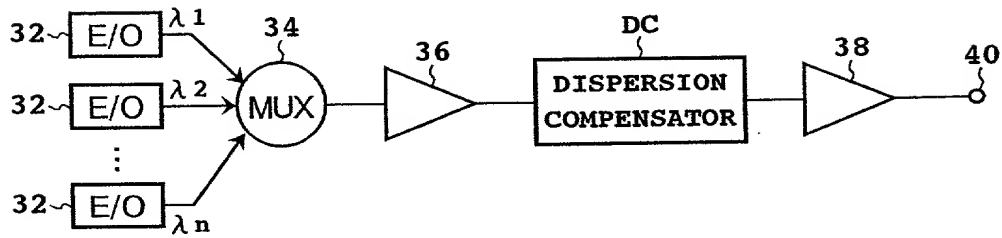
FIG. 2C

<u>4</u>

26

28

DC

30

○ → ▷ → DISPERSION COMPENSATOR → O/E

FIG. 3A

2

FIG. 3B

10

FIG. 3C

4

F I G. 4
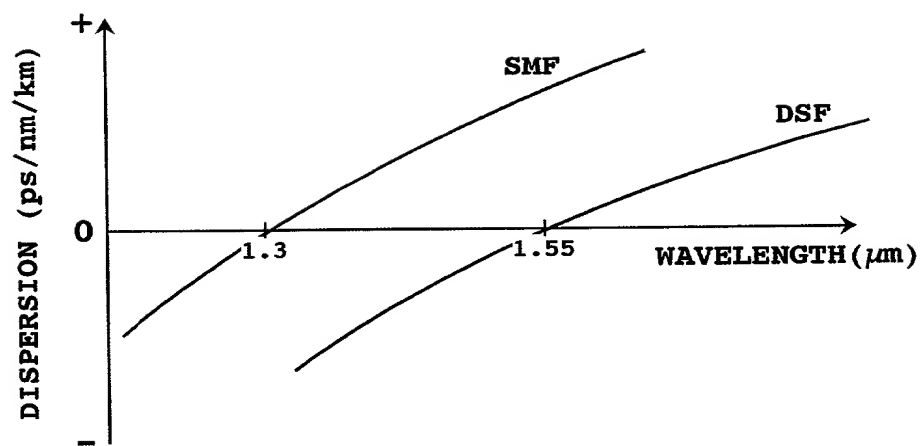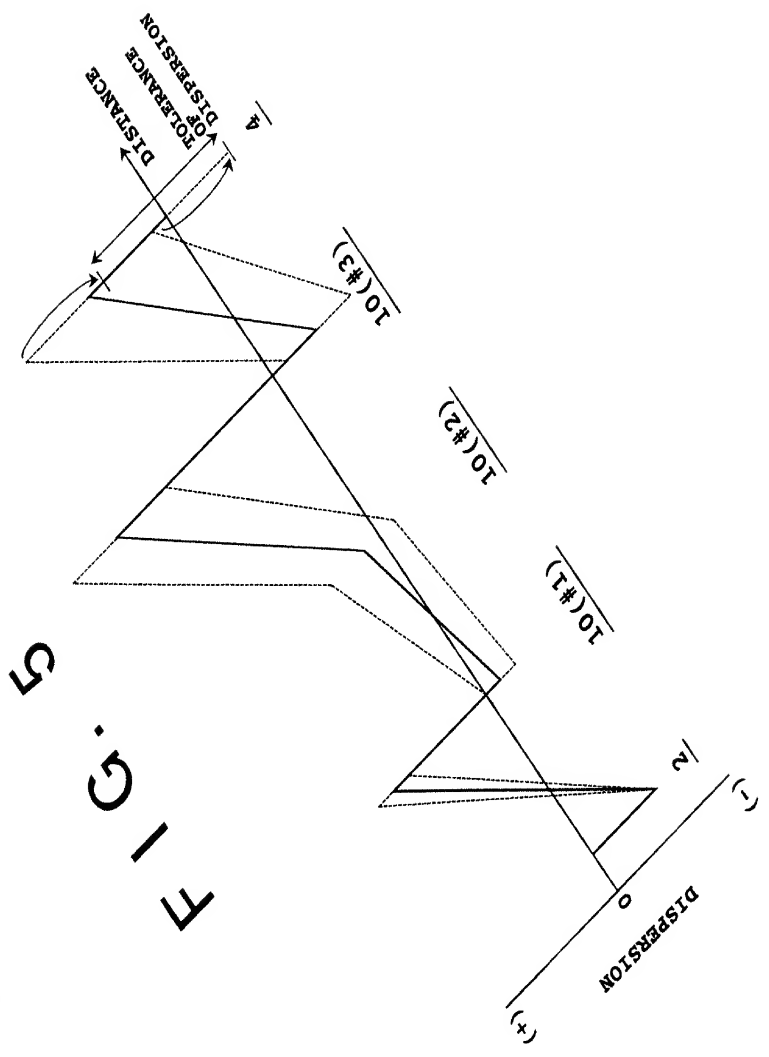
FIG. 5

DISTANCE

TOLERANCE
OF
DISPERSION

4

10(#3)

10(#2)

10(#1)

2

0

DISPERSION

(+)

(−)

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As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

_____

_____

METHOD AND SYSTEM FOR OPTICAL TRANSMISSION ADOPTING DISPERSION COMPENSATION

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

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（該当する場合）_____ に訂正されました。

☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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Prior Foreign Application(s)
外国での先行出願

			Priority Not Claimed 優先権主張なし
11-037837	Japan	16 February 1999	
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	☐
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	☐

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(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)
(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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